AN AUTOMATIC PROCEDURE TO EXTRACT GALAXY CLUSTERS FROM CRONARIO CATALOGUES

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ABSTRACT. We present preliminary results of a simple peak finding algorithm applied to catalogues of galaxies, extracted from the Second Palomar Sky Survey in the framework of the CRoNaRio project. All previously known Abell and Zwicky clusters in a test region of $5^\circ \times 5^\circ$ are recovered and new candidate clusters are also detected.
This algorithm represents an alternative way of searching for galaxy clusters with respect to that implemented and tested at Caltech on the same type of data (Gal et al. 1998).

1. Introduction

Clusters of galaxies are the largest known virialized structures and represent the high-density peaks of the large scale structure of the Universe which is effectively traced up to $150h^{-1}$ Mpc or more (Bahcall & Soneira 1984; Tully 1987). The distribution and the evolution of intrinsic properties of galaxy clusters provide important information for studies of galaxy and cluster evolution and on the dependence of galaxy properties on the environment.
In the past, a number of cluster catalogues (cf. Abell 1958; Abell et al. 1989; Zwicky et al. 1961-68) has been extracted from photographic all-sky surveys. These catalogues, however, were compiled by visual inspection of the plates and lack the homogeneity and completeness which is needed for statistical studies (Postman et al. 1986; Sutherland 1988).
Machine extracted catalogues (Dodd & MacGillivray 1986; Dalton et al. 1992; Lumsden et al. 1992) selected with more objective criteria, reach, in some cases, fainter limiting magnitudes but do not cover equally wide areas of the sky. More recently, CCD surveys have been carried out (Couch et al. 1991; Postman et al. 1996; Olsen et al. 1999), but they cover small regions of the sky and target deeper objects.

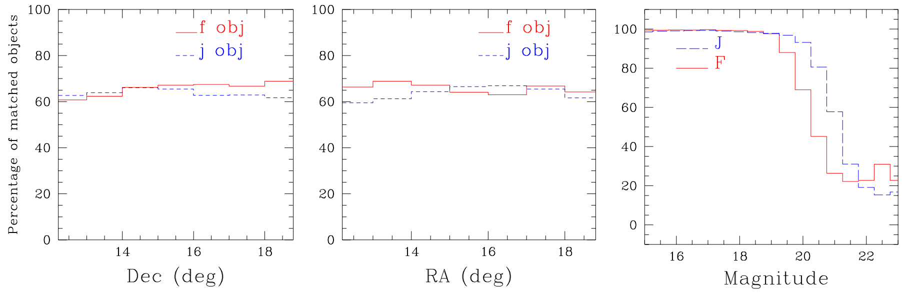

Fig. 1. Fraction of matched F-J objects versus the original F (continue line) and J (dashed line) objects as a function of right ascension (left), declination (center), and J and F instrumental magnitudes (right).

2. The CRoNaRio data

The CRoNaRio project (Djorgovski et al. 1998) is a joint enterprise between Caltech and the astronomical observatories of Monte Porzio, Napoli and Rio de Janeiro, aimed to the production of the Palomar Norris Sky Catalogue (Djorgovski et al. 1999), which will eventually include all objects visible on the Second Palomar Sky Survey and therefore will provide a large database from which to extract a statistically well defined catalogue of putative galaxy clusters (see Gal et al. 1999). For each POSS-II field the CRoNaRio project provides astrometric, geometric and photometric information (J, F and N bands, calibrated through CCD frames in the g, r, i bands of the Gunn-Thuan system).

The procedure for the search of cluster candidates, discussed in this paper, has been developed at the Astronomical Observatory of Capodimonte (Naples) and differs in many points from the standard way of preparing and generating the DPOSS distributable catalogues. The first step of our procedure requires the cleaning of the catalogues from spurious objects and artifacts (such as multiple detections coming from extended patchy objects, halos of bright stars, satellite tracks, etc.), which are present in the single filter catalogues. We mask and keep memory of the plate regions occupied by bright, extended and saturated objects (that locally make the detection extremely unreliable), taking this troubled areas into account in the next steps. Subsequently, the procedure performs the matching of the catalogues of the same sky region obtained in the three bands. This is done through the plate astrometric solution, matching each object in one filter with the nearest objects in the two other filters and assuming a tolerance box of 7 arcsec.

The quality of the matching does not depend on the position of the objects on the plates: the fraction of the matched objects with respect to the original single filter catalogue is quite constant all over the plate (Fig.1, left and central panel). The quality of the matching depends, as expected, on the instrumental magnitude: at faint magnitude a significative fraction of objects (too faint to be detected in some among the three filter) is lost in the matching process (Fig.1, right panel).

Due to the different S/N ratios in the three bands, many objects have discordant star-

galaxy classifications in catalogues from different filters. The number of such objects obviously increases at faint magnitudes. (It needs to be stressed, however, that this problem is greatly reduced when a new training set for the classification is adopted, see Gal et al. 1999 for details).

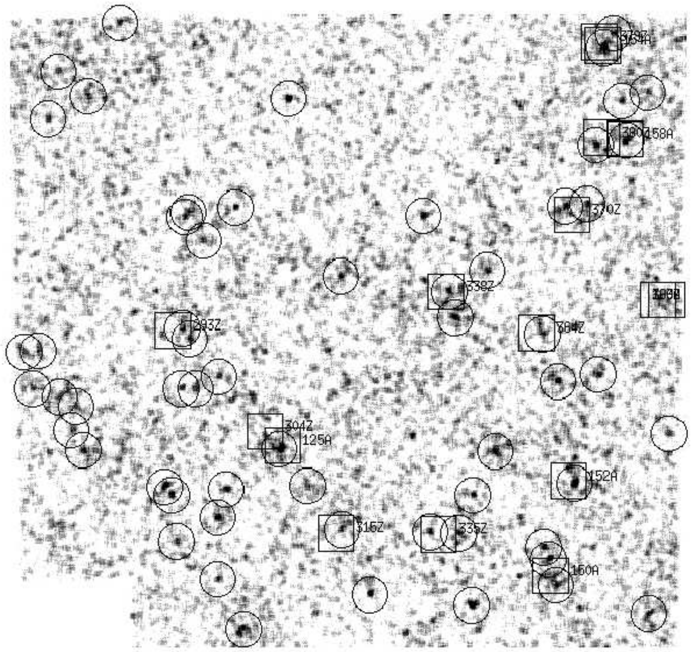

Fig. 2. Detected overdensities in the smoothed map in the plate n. 610. Squares mark known Abell and Zwicky clusters. Circles mark putative - previously unknown - clusters.

3. The identification of cluster candidates

In what follows we shall refer to POSS-II field n. 610 ($5^\circ \times 5^\circ$ centered at RA = 1h and δ =+15°). After matching and taking into account the above mentioned problem of misclassified objects, we first produced a catalogue of galaxies which is almost complete down to F $\sim$ 19.75 and J $\sim$ 20.21 mag. The spatial galaxy distribution in this catalogue was then binned into equal-area square bins of 36 arcsec in the sky and the resulting density map was smoothed with a Gaussian 2-D filter having a variable width chosen in function of the estimated cluster redshift in order to have a $\sim$ 250 kpc resolution (i.e., the dimension of the core radius of a typical cluster). Then, SExtractor (Bertin & Arnouts 1996) was run on the smoothed map in order to identify and extract all overdensities having number density 3σ above the mean background and covering at least 16 pixels (9.6 arcmin). In this way, as in the Schectman (1985) approach, we are not assuming any *a priori* cluster model.

All the previously known Abell, Zwicky or X-ray clusters were recovered and many new candidates were detected (see Fig.2).

4. Conclusions

We implemented a simple, but well understood and model independent, procedure for cleaning CRoNaRio catalogues from spurious sources. The procedure has been used to select the galaxy catalogues used for the determination of the LF of galaxy clusters and for the search of poor galaxy groups (Paolillo et al.; De Filippis et. al.,these Proceedings). Our next goal is to validate our detections by cross-identification with X ray catalogues of galaxy clusters or by direct optical observation.

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